WATER MASTER PLAN
FOR
CALIFORNIA CITY

Quad Knopf

September 2002

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for
CALIFORNIA CITY

September 13, 2002

Submitted to:

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ADD	average daily demand
AVEK	Antelope Valley-East Kern Water District
bgs	below ground surface
ea	each
ft	feet
gal/day	gallons per day
gal/house	gallons per house
gpcd	gallons per capita per day
gpm	gallon per minute
µg /L	micro gram per liter
lf	linear feet
LS	Lump Sum
MDD	maximum daily demand
MG	million gallons
MGD	million gallons per day
min/day	minutes per day
PHF	peak hour flow
psi	pounds per square inch
PVC	Polyvinyl Chloride
TOU	time of use
UFC	Uniform Fire Code
USGS	U.S. Geological Survey

I Introduction

This report is a "Master Plan" for City of California City water supply and distribution system. The objective of the Master Plan is to analyze the existing water system, identify existing deficiencies and recommend system improvements to meet current and future needs. The time frame for the Master Plan is to the year 2020.

California City produces over one billion gallons of water annually to supply a population of nearly 11,000 residents in a service area encompassing over 200 square miles. The City is geographically the third largest in California. A water distribution system is in place to serve most of the City. Significant additional water supply is necessary to serve the City as it grows.

California City is a high desert community located in eastern Kern County in the Mojave Desert. Annual average precipitation is approximately 5 inches. Elevation in the First Community varies from 2,350 to 2,500 feet. The only water sources available are groundwater and imported surface water supplied by the Antelope Valley East Kern Water District (AVEK).

Most of the water system was installed prior to 1972 with the initial construction of streets and lots in California City. The water system was originally owned and operated by the California City Community Services District until its takeover by the City.

This Master Plan is the first prepared for the City and covers the "First Community" and the "Rancho Tract." The "First Community" is the central core of the City and includes over 75 percent of the population and virtually all housing. The "Second Community" is located to the east of the First Community and contains the higher elevation land area within the City. The privately owned California City prison is located in the Second Community. It currently accounts for about 23 percent of the City population when it is operating at its 2,500 bed capacity. The Master Plan study area is shown in Figure I-1, encompasses approximately 35 square miles. The Master Plan considers the "Second Community" only in the production and allocation of the existing supply of water.

The water Master Plan has been prepared in conjunction with the preparation of "base maps" for the City. These maps include a digital aerial photo, street centerlines, street names, parcel lines, water lines, sewer lines, storm drain lines and other geographic based data. A sewer Master Plan and drainage Master Plan are also in preparation.

Acknowledgements

Quad Knopf wishes to acknowledge and thank Jack Stewart, City Manager, Jim Schroeter, P.E. City Engineer, Ron Wallace, Public Works Director, Tony Langin, Frank Lane and Hoss Pegram for their valuable assistance in preparing the Master Plan.

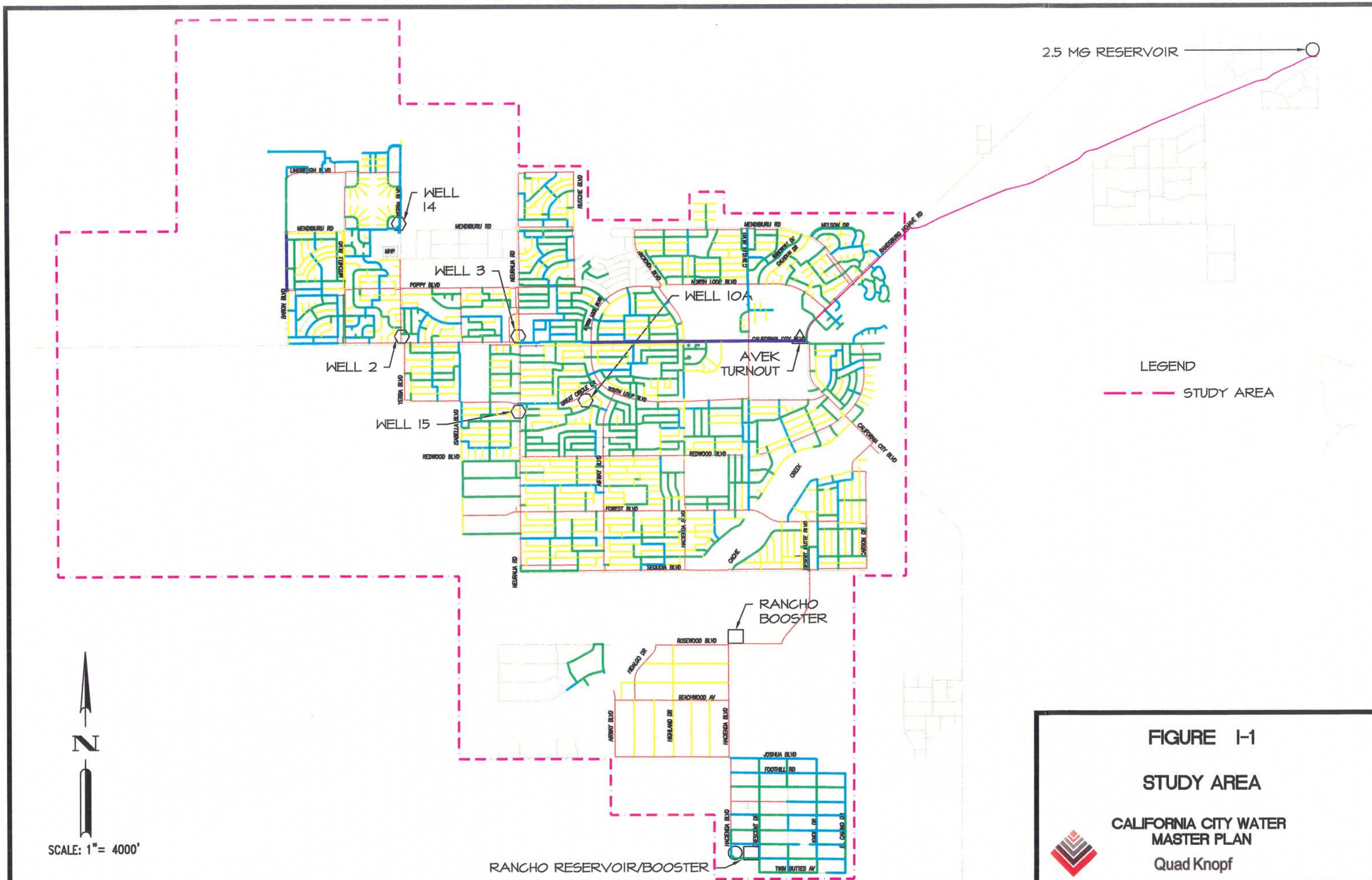

FIGURE I-1

STUDY AREA

CALIFORNIA CITY WATER MASTER PLAN

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II Executive Summary

California City, with a current population of approximately 10,800, utilizes over a billion gallons of water annually. This water consumption amounts to approximately 340 gallons per person per day (gpcd) for an average total of 3.25 million gallons per day (MGD). The city is projected to grow, under a medium growth rate scenario, to a population of over 20,000 persons by year 2020. At that time, average day water demand (ADD) is projected to grow to 6.4 MGD. The maximum day demand (MDD) will be 2 times ADD and the peak hour flow will be 3 times ADD. This report presents a Master Plan to guide the City in the improvement of the water system to meet water needs to the year 2020. The Master Plan study area is the "First Community" and the Rancho Tract.

The major deficiency in the existing water system is the integrity of steel water mains. These mains, constructed originally in the early 1970's of used uncoated steel, are severely corroded and prone to leak. The Master Plan proposes a water main replacement program that will replace all steel pipelines with new 6-inch, 8-inch and 12-inch water mains. The estimated cost of this program is over $42 million. The program should be implemented immediately with water mains replaced in a systematic program over the next 10 to 15 years.

The City currently has five water wells and a turnout to the Antelope Valley-East Kern Water District (AVEK). Five new 1,000 gallon per minute (gpm) water wells must be constructed to meet the 2020 water supply needs of the City. One new water well is needed immediately. Alternatively, the City can consider increasing utilization of AVEK water and reduce the number of new wells constructed. We strongly encourage the City to maximize its utilization of AVEK water to maintain a priority of use.

Currently available water storage volume or its equivalent is approximately 9.3 million gallons (MG). Water storage requirements for year 2020 totals 16.7 MG. Three new 2.5 MG water reservoirs are proposed to meet storage requirements. A new reservoir site, approximately 1.75 miles west of Baron Blvd on California City Blvd, is proposed for two new 2.5 MG reservoirs. A 16-inch transmission main, constructed in California City Blvd, would feed the reservoir. The third 2.5 MG reservoir will be constructed adjacent to the existing 2.5 MG reservoir located on Twenty Mule Team Parkway. All reservoirs would be constructed at the same elevation. Collectively the reservoirs and their equivalent (AVEK and engine driven well pumps) will provide emergency storage of one maximum day demand.

A 16-inch water main loop is proposed to increase the distribution system capacity. The loop will interconnect water wells, the AVEK turnout and water reservoirs on the east and west side of the First Community. Twelve-inch water mains will be constructed at approximately one-mile intervals and in major industrial and high value commercial zones.

Other Master Plan improvements proposed include:

- Installation of chlorination facilities on the AVEK turnout
- Addition of a 1,000 gpm fire pump at the upper Rancho Tract hydropneumatic zone.
- Relocation of the pressure zone boundary at the Rancho Tract to reduce high pressure below Joshua Blvd. A new 10-inch water main will be constructed from the lower Rancho Tract booster pumps to Joshua Blvd. An 8-inch loop connection will be added to feed the lower Ranch Tract from two locations.

Implementation of the Master Plan will occur in phases over the next 18 years. The Master Plan improvements are estimated to cost approximately $14 million. Total water system improvements will cost approximately $56 million. Water main replacement costs should be spread to all parcels in the First Community with water availability. Master Plan costs, to the extent they serve new development, should be borne by that development.

III Existing Water System

System Overview

Water systems are generally considered to have four major components:

- Transmission and distribution
- Supply
- Treatment (when required)
- Storage

The transmission and distribution system consists of water mains and pipelines that deliver water from its source(s) to the customer. Transmission pipelines are generally larger size mains with the primary purpose of transporting water from major sources or to and from treatment, storage and pumping facilities. Transmission lines may also interconnect different pressure zones or service areas within a distribution system.

The distribution system consists of water mains that directly deliver water to the customer. Service laterals and fire hydrants are directly connected to distribution water mains. A distribution system generally consists of water mains with a diameter of 4 inches to 12 inches.

Transmission and distribution systems also include pumping facilities required to transmit water to upper pressure zones or to boost pressure from a ground level tank or reservoir.

Water supply may consist of groundwater wells or surface water obtained locally or imported from outside the area.

Surface water is required to be treated to federal and state drinking water standards prior to delivery to the customer. Groundwater may also require treatment, but is often of good enough quality to be used directly by the customer. Groundwater is often disinfected with chlorine to ensure its safety to the customer.

Storage facilities consist of tanks or reservoirs used for equalizing flow, fire storage and emergency storage. Storage facilities can be underground, ground level or elevated.

Transmission and Distribution System

California City encompasses an area of over 200 square miles ranging in elevation from 2,300 feet to nearly 4,000 feet. A total of 15 pressure zones are designated so that water pressure falls within acceptable pressure ranges (usually between 40 to 100 psi). The First Community varies in elevation between 2,350 feet and 2,500 feet and is entirely contained in a single pressure zone, B1. The developed area of the First Community consists of approximately 15 square miles.

A 2.5 million gallon (MG) reservoir, located on Twenty Mule Team Parkway, about 7 miles northeast of City Hall, has a high water elevation of 2,594 feet which sets the maximum static pressure within Zone B1 (Photo Plate 1, Appendix A). The Rancho Tract contains two separate pressure zones and varies in elevation from 2,700 feet to 2,400 feet. Pressure Zone C2 is fed from a reservoir located at the upper end of the Rancho Tract, about 5 miles south of City Hall (Photo Plate 2). Water is pumped to the Rancho reservoir from the lower Rancho booster pump station located on Hacienda Blvd. at Rosewood Blvd. (Photo Plate 3). The high water level of the Rancho Reservoir is 2,710 feet. A hydro-pneumatic pressure zone serves the highest elevations of the Rancho Tract, above elevation 2,600 feet. The upper Rancho hydropneumatic system consists of two booster pumps and a 5000 gallon hydropneumatic tank (Photo Plate 4). The remaining pressure zones are located within the Second Community and are not considered in the Master Plan. Figure III-1 shows the existing water system.

The California City water distribution system consists of water mains ranging in size primarily from 4 inch through 10-inch diameter. Some 12-inch diameter pipe exists but it is a minor quantity. A 20-inch diameter transmission main extends from California City Blvd. at Randsburg Mojave Road and then northeasterly along Twenty Mule Team Parkway to the 2.5 MG reservoir.

Most water mains in the distribution system were originally installed during the late 1960's and early 1970's. Much of the water pipe was previously used, uncoated steel. It has now been in place over thirty years and has passed its useful life. Significant corrosion has occurred and the steel pipes develop leaks constantly. Consequently, virtually all original steel water pipes are in need of replacement. The City has replaced some steel pipe in replacement programs in 1984 and 1986-87. Steel pipe was replaced with asbestos cement pipe in an area bounded by Redwood Blvd., Neuralia Blvd., South Loop Road and Hacienda Blvd.. Other pipe has been replaced on an as-needed basis. More recently, pipe has been replaced with PVC. The current repair as required, band-aid approach, must be replaced with a systematic water main replacement program.

California City, has perhaps, one of the largest water distribution systems in place in California for the number of customers served. The City maintains a distribution system in the First Community covering 15 square miles with only approximately 3,200 service connections. The small number of customers, relative to the miles of distribution pipe in place, creates a tremendous maintenance burden on the City. This, coupled with the aging steel pipe, makes the City water system vulnerable to failure and waste of water due to leaks.

Supply

California City obtains its water from five groundwater wells and an imported surface water supply from the Antelope Valley-East Kern Water District (AVEK). Groundwater wells produced over 93 percent of the water supply in 2000 and 2001. The water wells draw from an underground aquifer located beneath a portion of the First Community. Groundwater depth is approximately 330 to 390 feet below ground surface (bgs). The water wells presently produce between 800 and 1000 gpm each. Data on the five water wells is summarized in Table III-1. Photo Plates 5 through 9, Appendix A, show the water wells. Copies of pump curves are included in Appendix B. There is no significant source of water supply in the Second Community. All water for the Second Community originates in the First Community from wells or the AVEK supply.

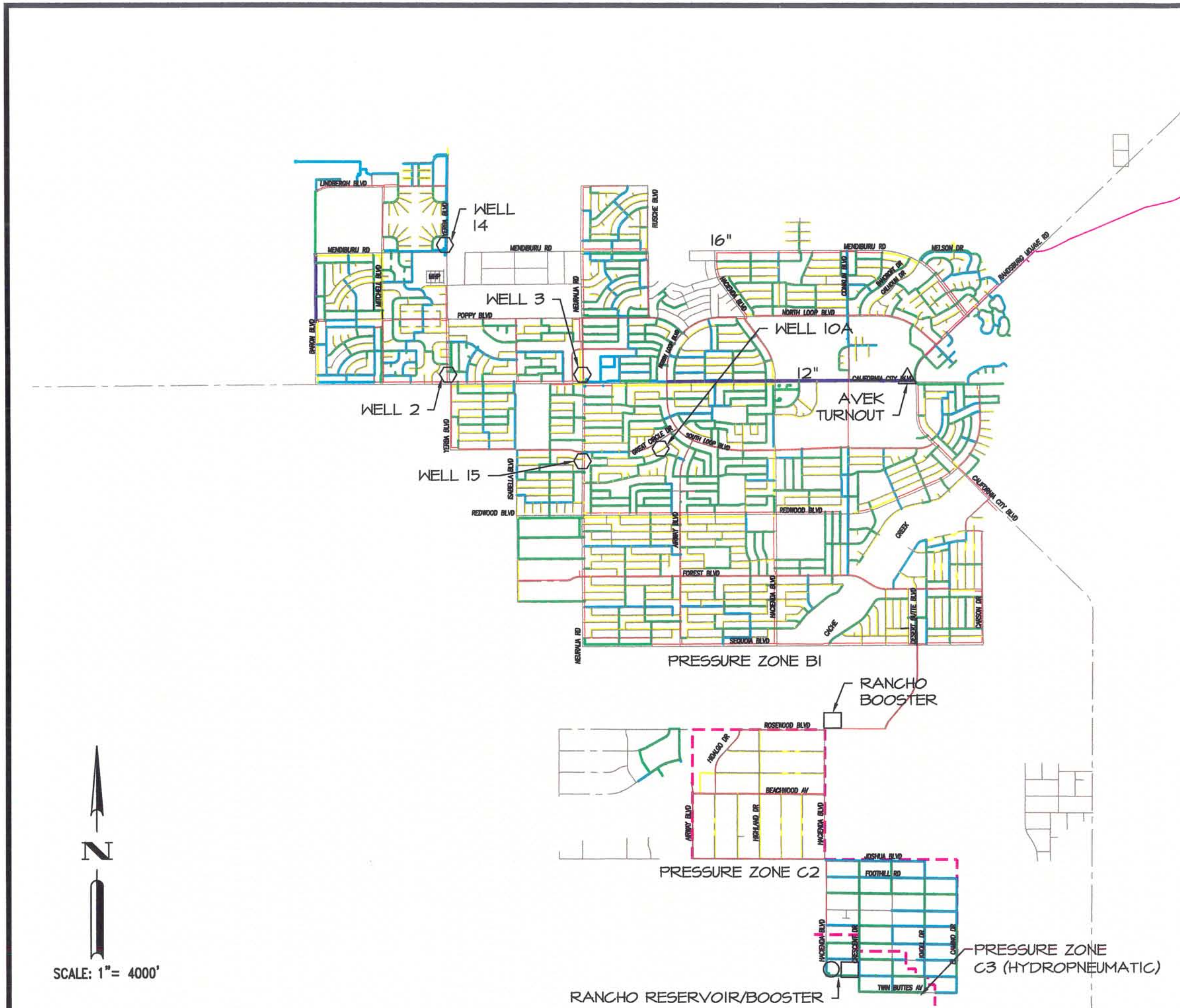

FIGURE III-1

EXISTING WATER SYSTEM

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AVEK is a state water supply contractor with an entitlement to surface water from the California Water Project. AVEK delivers water to Rosamond, Mojave, Edwards Air Force Base, Boron and other communities in the Antelope Valley, East Kern area. A map of the AVEK system is included in Appendix C. AVEK water is delivered from the East Branch of the California Aqueduct to a raw water pipeline (West Feeder) and is treated at a 14 MGD water treatment plant located in Rosamond. Treated water is conveyed via the Central Feeder to the Mojave Reservoirs, a 32 MG tank farm. From the Mojave Reservoirs, water is conveyed by gravity via the North Feeder pipeline which branches into the California City feeder, an 18 inch pipeline. The California City feeder is 43,200 feet long. AVEK water flows by gravity to the California City turnout at California City Blvd. and Randsburg-Mojave Road.

A pressure reducing station, consisting of two 8-inch combination pressure reducing check valves with rate of flow controllers and flow meters, connects to the distribution system. AVEK water use is currently controlled manually by opening and throttling a valve. The AVEK connection has a gravity feed capacity of approximately 1,700 to 2,000 gpm. Photo Plate 10 shows the AVEK turnout.

AVEK has a State Water Project entitlement of 141,400 acre-feet per year and currently utilizes approximately 70,000 to 80,000 acre-feet per year. State Water Project water is subject to reductions in supply based on water supply availability, particularly in northern California, the source of supply. AVEK water delivery is also subject to Aqueduct interruptions. The AVEK water supply is thus not 100 percent reliable and is considered a supplemental water supply. California City is required to purchase a minimum of 0.5 acre-feet per month. Each year, the City must make a request to AVEK for the amount of water desired for the year. In 2001, the City purchased 317 acre-feet from AVEK. The current cost of AVEK water is $220/ acre-foot.

AVEK water is considered by the City to be less desirable than use of local well water because of its high cost, taste and low chlorine residual.

Treatment

Groundwater currently does not require treatment to meet current state and federal drinking water standards. Chlorine is added at each well to disinfect the water and protect the water distribution system. Chlorine is added so that a residual is maintained throughout the distribution system. The chlorine residual protects the water from potential contamination originating from the distribution system. The City utilizes a salt generating system to produce chlorine for injection at the well head. Salt and electric energy are utilized to produce sodium hypochlorite (liquid chlorine bleach) at non-hazardous concentrations.

A copy of the most recent Consumer Confidence Report on California City water is presented in Appendix D. This report is mailed annually to all City water customers. It provides the most recent report on all applicable water quality standards. It is notable to report that the City currently meets the newly issued arsenic standard of 10 μg /L.

Table III-1

Water Well Summary Data

Item	Well 2a	Well 3	Well 10	Well 14	Well 15a
State well number	32S/37E-22NO3M		32S/37E-26G01M	32S/37E-16N01M	32S/37E-26M02M
Location	Yerba @ CA City Blvd.	CA City Blvd. @ Neuralia	8500 & 8512 Great Circle	22000 Mendiburu Blvd.	20380 Neuralia
Date drilled	5/10/94 to 7/11/94				3/5/1984
Well depth	813 ft	583 ft	529 ft		750 ft
Perforated interval	450 to 755 ft		350 ft		475 ft x 80 ft & 680 ft x 60 ft
Casing diameter	16 inches		16 inches	16 inches	16 inch
Casing depth (ft -bgs)	755		500		605
Static water level (ft- bgs)	388		328	365	342.4
Pumping water level (ft - bgs)	497		339	402	409.4
Depth to bowls (ft-bgs)	580		553	n/a	n/a
Pump bowl elevation (ft)	1863.68	1850 (a)	1836.91	1850 (a)	1850 (a)
Ground elevation (ft)	2443.68	2400.85	2389.91	2423.25	2408.38
Groundwater static elevation	2055.68	2060 (a)	2061.91	2058.25	2065.98
Groundwater Pumping elevation	1946.68	2000 (a)	2050.91	2021.25	1998.98
Pump make	American Turbine		Peerless		Peerless 18A 11 stg.
Pump type	O/L lineshaft		Water lube		Water lube
Motor horsepower	250 hp	618 hp	150 hp	200 hp	250 hp
Motor type	US Electric	1113 CID V-12 Waukesha Natural Gas Engine	Westinghouse	RUE	Yaskawa
RPM	1770 rpm	1200 rpm	1775 rpm	1770 rpm	1780 rpm
Production capacity (b) (gpm)	900	800	875	850	1000

Notes :

(a) estimated or assumed value

(b) August 2002

AVEK water is treated at the Rosamond Water Treatment Plant prior to delivery to the City. AVEK water meets all current state and federal drinking water standards. AVEK water typically has low chlorine residual at its turnout in California City, probably because of the low delivery rate and long feeder pipeline. Typical of treated surface water, AVEK water is more prone to taste problems.

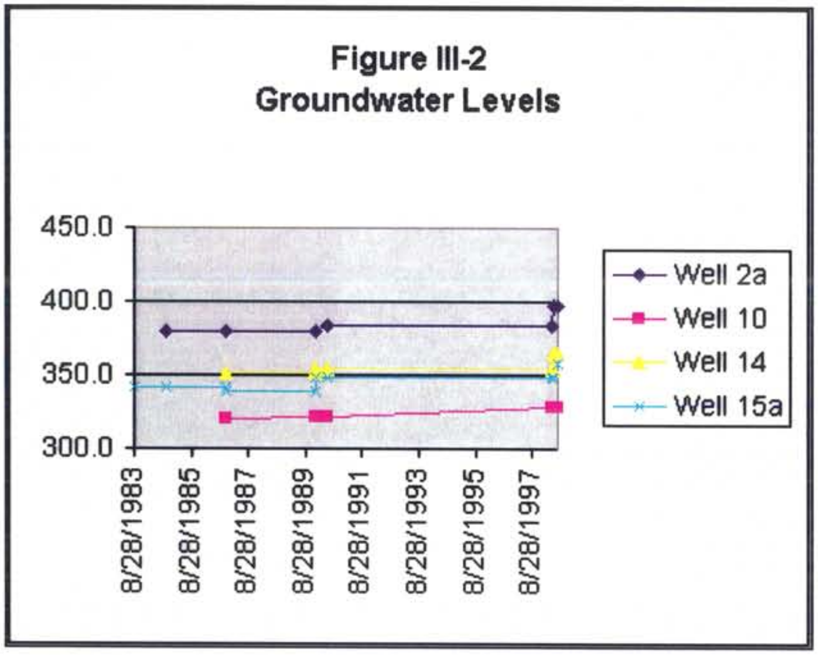
Storage

The most important storage system is the groundwater aquifer. The aquifer holds water at a depth of approximately 320 to 380 feet below ground surface (bgs) in underground sands and gravels at a quality suitable for direct use. Its value as storage is limited only by the ability to reliably retrieve the water by pumping. There has been much debate about the sustained yield of the aquifer, the quantity of recharge and the long-term reliability of the aquifer. These issues are not within the scope of the water Master Plan. It is known that the water table has been stable and has actually risen slightly since 1983 (Table III-2 and Figure III-2).

Table III-2

Water Wells - Depth to Groundwater (ft bgs)

Date	Well 2a	Well 10	Well 14	Well 15a
8/28/1983				342.4
10/2/1984	380.0			
11/12/1986		320.4		
11/12/1986			351.0	338.9
1/17/1990		322.2		
1/17/1990			353.4	
1/17/1990				348.8
6/13/1990				
4/29/1998		328.8		
5/20/1998	397.1			
5/20/1998			365.3	
7/16/1998	397.1			357.9



For the purpose of this Master Plan, it is assumed that the aquifer will continue to yield sufficient water to sustain the City for at least the next twenty years.

California City currently has five above ground reservoirs as summarized in Table III-3. The primary reservoir for the First Community is the 2.5 MG reservoir located on Twenty Mule Team Parkway (Photo Plate 7, Appendix A) in pressure zone B-1 . This reservoir currently provides the only storage for the First Community. It also serves as temporary storage for water transferred uphill to the Second Community via the Second Community booster pump station (Photo Plate 11).

Table III-3

Storage Summary

Reservoir	Capacity (MG)	Elevation Top capacity level
First Community (Ph I)	2.5	2,594
Rancho	0.21	2.710
Phase II	1.0	
Phase III	1.0	
Phase IV	1.0	
Total Capacity	5.71	

IV Water System Planning Criteria

This section presents planning criteria used to evaluate the existing system and to master plan the future system. The criterion represents a synthesis of commonly used parameters from many water districts, accepted water industry standards, engineering textbook recommendations and engineering judgment. These parameters have been adapted to apply to the local conditions and to the common practice of California City. In many cases, criteria may be presented in a range, rather than a single value. Exceptions to planning criteria are acceptable, provided that variances are minimal and inconsequential or are impractical due to cost, disruption in service or inconvenience. All exceptions should be reviewed and approved by the City Engineer and Public Works Director.

Transmission and Distribution

Transmission and distribution system planning criteria relate to the size, acceptable velocity and friction headloss within water mains and to the pressure within the distribution system. Criteria proposed for California City are:

Table IV-1

Transmission and Distribution System Planning Criteria

Parameter	Units	Value	Notes
Minimum distribution pipe size	inches-diameter	6	a
Normal distribution pipe sizes	inches-diameter	6, 8, 12	b
Minimum industrial area main size	inches-diameter	12	c
Fire hydrant spacing - residential	feet	500	
Fire hydrant spacing – commercial/ind.	feet	250	
Maximum distribution main velocity	ft/sec	6	d
Maximum transmission main velocity	ft/sec	8	d
Maximum pressure	psi	120	e
Minimum pressure at max day (MDD)	psi	40	
Minimum pressure at peak hour (PHF)	psi	30	
Minimum pressure adjacent to fire	psi	20	

Notes:

a. Minimum size required to feed a fire hydrant. Six-inch size should be limited to short length cul de sac or dead end lines less than 150 feet in length.

b. Normal distribution sizes are based on the most commonly available sizes. Although 10-inch pipe could be used, it is not as common as 8 or 12-inch pipe. Other than cul de sacs and short runs, 8-inch should be the default water main size.

c. A 12-inch main is recommended because of the high fire flow requirements typical in an industrial area. 12-inch mains are also recommended in high value commercial areas.

d. Pipe size should also be evaluated on the basis of friction head loss.

e. Pressures greater than 80 psi require individual pressure regulators.

Fire Flow

Fire flow requirements in California City are governed by the Uniform Fire Code (UFC) as set forth in Division III, Appendix III-A. The UFC sets the required fire flow for a building on the basis of several parameters including the floor area, fire rating of construction, the presence/absence of fire sprinklers and other parameters. The California City Fire Chief has recommended that the following criteria be used for generalized planning purposes:

- Single family homes (less than 3600 sq. ft): 1,500 gpm for 1 hour. Required volume is thus 90,000 gallons. The actual UFC requirement is 1,000 gpm.
- Commercial/Industrial: 4,000 gpm for 3 hours. Required storage volume is 720,000 gallons.
- Residual pressure at the hydrant must be 20 psi or greater.

The Fire Chief has the authority to increase or decrease the required fire flow at his discretion.

If a commercial or industrial project cannot meet the UFC requirements directly from the distribution system, on-site fire storage and fire pumps can be provided. The use of fire sprinklers in a building can result in up to a 75 percent reduction in required fire flow.

Water Supply

Water supply must simply be greater than demand or water use restrictions must apply. Supply must also consider the reliability of the water source and the probability of reductions in supply. The City must consider the possibility of disruption in supply due to mechanical breakdown or to natural disasters such as earthquakes and floods.

The groundwater supply is considered very reliable in the short term and subject primarily to mechanical breakdown of pumps and chlorine feed equipment. In the longer term, water well screens eventually plug and require rehabilitation. Yields often decline slowly over time due to decline of the groundwater table, pump wear or well screen plugging. The city should consider that, at any time, the largest capacity well would be out of service for up to one month. Therefore, the available capacity of the groundwater should be rated with the largest well out of service. As the City constructs more wells, it may be prudent to consider that two of the largest capacity wells will be out of service.

The AVEK water supply is subject to State ordered cutbacks in allocation. For instance, the allocation for 2002 from the State to AVEK is 65 percent of their entitlement. The allocation in 2001 was 39 percent. AVEK will in turn cut back allocation of water to its customers. Fortunately, AVEK currently uses only about 43 to 57 percent of its entitlement and thus cutbacks are not critical at this time. However, in the future, the reliability of the AVEK supply will diminish as demand for AVEK and State Water Project water grows.

It is recommended that the water supply meet the maximum day demand (MDD) with the largest well out of service. MDD is the demand on the highest water use day of the year. In California City, this day generally occurs during the month of July. July is typically the month with the highest average flow. AVEK is assumed to supply its current maximum rate of flow of 1,700 gpm. If AVEK cutbacks are in place, then the water supply must meet the maximum month average flow. The water supply should be in place and operational at least three to five years ahead of the demand. The supply must keep ahead of the demand so that there is adequate time to plan, complete environmental reviews, design and construct new facilities.

Peak hour flows are to be met from use of equalizing storage. Within a 24-hour period, flow will enter storage reservoirs during low use times (generally late night) and will exit storage during high use periods to meet peak hour periods.

Storage

The total volume of storage for a water system consists of three components:

- Operational or equalization storage
- Fire Storage
- Emergency Storage

Operational storage is the quantity of water required to equalize variations in water system demand over a 24-hour period. During a 24-hour period, demand varies considerably with low flow perhaps one-half of the average 24-hour flow and peak flows 1.5 to 2 times the average 24-hour flow. Assuming a near constant rate of water production, water enters storage reservoirs during low demand periods and exits during high demand periods. Equalizing storage generally is equal to 20 to 30 percent of the maximum day demand (MDD). A storage volume equal to 25 percent of MDD is commonly used and is recommended for California City

Fire storage is based on UFC requirements. Generally, only one fire event is considered at a time. The highest fire storage requirement is used to determine storage volume. A fire flow of 4,000 gpm for 3 hours yields a fire storage volume of 720,000 gallons (0.72 MG).

Emergency storage requirements are based primarily on the reliability of the water system and the availability of backup sources. Generally, it is recommended that emergency storage (or equivalent to storage) equal the maximum day demand (MDD). During a true emergency, one maximum day demand in storage, with water rationing and public awareness of the emergency, can last for several days.

AVEK provides an independent backup source to the City. Its primary vulnerability is the long distance from the source and the possibility of pipeline failure or leakage. Storage located in upper pressure zones, such as the Phase II, III and IV tanks, can be considered as emergency storage if it is possible to release the water to the lower pressure zones. Water wells with emergency power can also be considered as the equivalent of storage. The groundwater aquifer provides the storage. Emergency power is required to pump the stored groundwater into the system.

Required storage is the sum of volume requirements for operational, fire and emergency. Thus, for master planning purposes, storage is recommended to equal 1.25 times MDD plus 720,000 gallons fire storage.

V Water Requirements

This section presents data on current and past waster use and develops predictions of future water demand based on population growth and historical water consumption. The most important factor in water demand is the climate within the service area. On an annual basis, relatively small amounts of water are used indoors for drinking, sanitation and cooking relative to water used for irrigation. The hot, dry desert climate contributes significantly to water use because of the high evapo-transpiration needs of landscaping. A second important factor in water demand is the cost of water and the presence or absence of water meters. Water meters are generally acknowledged as contributing significantly to water conservation. California City is a metered water system and currently supplies water at a low cost.

Current Water Use

A summary of water production for 2000, 2001 and the first 6 months of 2002 is presented in Table V-1. Table V-1 shows, by month, production for each well and AVEK purchases. It also shows transfers to Phase II, III, and IV. Water use in the First Community accounts for 68 to 77 percent of total water use.

The variation in monthly water use is shown in Figure V-1.

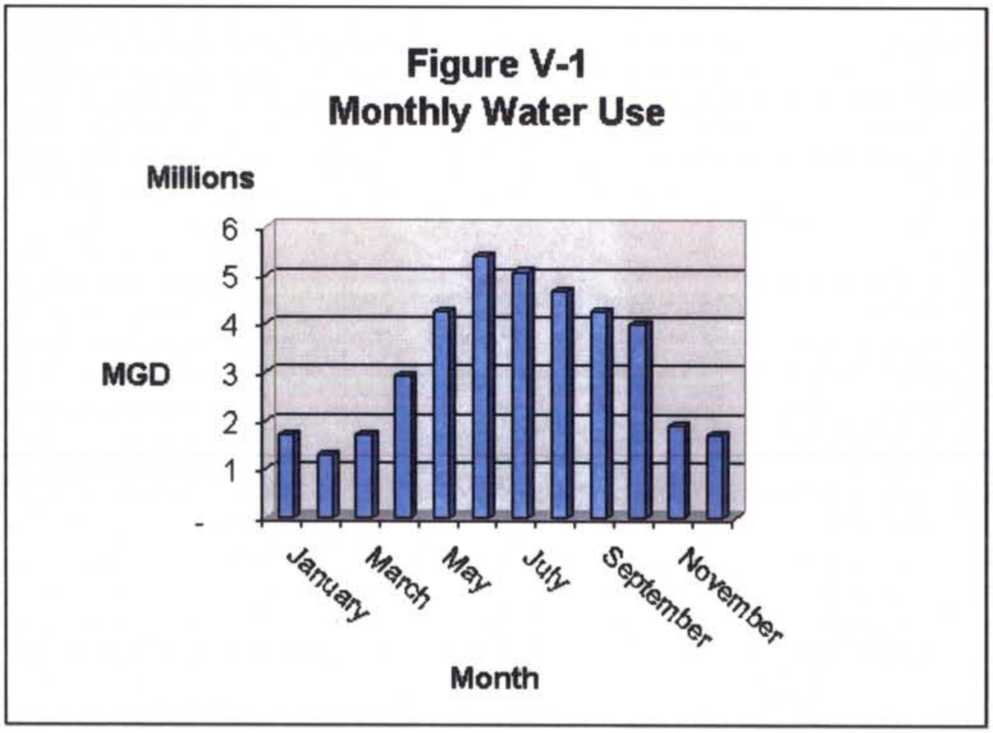


Table V-1

Water Production Summary (1,000 gallons except as noted)

Month	Groundwater Production (1000 gallons) Well 2a	Well 3	Well 10	Well 14	Well 15a	Total Groundwater Pumped	AVEK Purchase	Groundwater Production Losses	Total produced (1000 gallons)	Total Produced (AF)	Total Produced (gal/day)	Total Produced (gal/min)	Ph II,III,IV Total Transferred	Net Water 1st Community	1st Community (1000 gallons)	1st Community (gpm)	Phase II, III, IV (1000 gallons)	Phase II, III, IV (gpm)	AVEK (gpm)	Percent 1st cmty. (%)
2000																				
January	39,299	147	-	7,253	2,271	48,970	985	147	49,808	153	1,606,721	1,116	8,460	41,348	1,334	926	273	190	22	83%
February	41,072	34	-	7,179	1,160	49,445	963	34	50,374	155	1,799,083	1,249	7,000	43,374	1,549	1,076	250	174	24	86%
March	40,639	990	7,502	8,974	1,138	59,242	979	990	59,231	182	1,910,679	1,327	12,995	46,236	1,491	1,036	419	291	22	78%
April	46,671	46	11,639	30,825	6,776	95,956	919	46	96,830	297	3,227,656	2,241	20,975	75,855	2,528	1,756	699	486	21	78%
May	48,359	60	12,626	36,229	21,729	119,003	6,959	60	125,902	386	4,061,349	2,820	32,051	93,851	3,027	2,102	1,034	718	156	75%
June	43,756	346	15,287	35,301	33,845	128,535	24,911	346	153,100	470	5,103,326	3,544	39,661	113,439	3,781	2,626	1,322	918	577	74%
July	47,298	175	22,866	35,541	35,291	141,170	23,923	175	164,919	506	5,319,961	3,694	40,667	124,252	4,008	2,783	1,312	911	536	75%
August	40,114	407	22,030	34,173	31,765	128,489	22,887	407	150,968	463	4,869,947	3,382	38,730	112,238	3,621	2,514	1,249	868	513	74%
September	52,326	391	21,306	21,622	30,047	125,691	86	391	125,386	385	4,179,534	2,902	30,222	95,164	3,172	2,203	1,007	700	2	76%
October	28,985	165	21,039	10,941	30,555	91,685	1,141	165	92,660	284	2,989,045	2,076	22,742	69,918	2,255	1,566	734	509	26	75%
November	257	194	16,971	26,124	11,005	54,550	1,233	450	55,333	170	1,844,438	1,281	9,638	45,695	1,523	1,058	321	223	29	83%
December	420	144	12,908	33,158	7,541	54,170	16	144	54,042	166	1,743,291	1,211	8,664	45,378	1,464	1,017	279	194	0	84%
Annual total	429,195	3,100	164,172	287,319	213,121	1,096,907	85,003	3,356	1,178,554	3,617	-	-	271,805	906,749	-	-	-	-	-	77%
Max month	52,326	990	22,866	36,229	35,291	141,170	24,911	990	164,919	506	5,319,961	3,694	40,667	124,252	4,008	2,783	1,322	918	577	
Min month	257	34	-	7,179	1,138	48,970	16	34	49,808	153	1,606,721	1,116	7,000	41,348	1,334	926	250	174	0	
Average Month	35,766	258	13,681	23,943	17,760	91,409	7,084	280	98,213	301	3,221,253	2,237	22,650	75,562	2,480	1,722	742	515	161	
Average daily	1,176	8	450	787	584	3,005	233	9	3,229	10	3,228,914	2,242	745	2,484	-	1,725	-	517	162	
2001																				
January	583	132	6,149	37,621	7,816	52,300	1,159	715	52,744	162	1,701,419	1,182	6,917	45,827	1,478	1,027	223	155	26	87%
February	14,121	102	-	16,394	5,861	36,479	943	1,456	35,966	110	1,284,506	892	7,470	28,496	1,018	707	267	185	23	79%
March	39,218	110	0	741	11,609	51,678	1,019	110	52,587	161	1,696,365	1,178	17,354	35,233	1,137	789	560	389	23	67%
April	37,277	90	12,469	29,421	8,084	87,341	413	-	87,753	269	2,925,117	2,031	23,191	64,562	2,152	1,495	773	537	10	74%
May	37,121	691	20,237	37,125	30,746	125,920	6,077	-	131,997	405	4,257,983	2,957	39,774	92,223	2,975	2,066	1,283	891	136	70%
June	37,975	1,008	19,118	36,262	36,677	131,039	30,912	-	161,951	497	5,398,375	3,749	44,185	117,766	3,926	2,726	1,473	1,023	716	73%
July	37,872	2,624	19,699	36,147	37,580	133,923	23,455	-	157,378	483	5,076,697	3,525	45,376	112,002	3,613	2,509	1,464	1,016	525	71%
August	47,060	105	19,860	37,603	36,753	141,381	3,806	-	145,188	446	4,683,469	3,252	47,141	98,047	3,163	2,196	1,521	1,056	85	68%
September	37,586	67	18,896	35,196	31,266	123,011	4,288	-	127,298	391	4,243,271	2,947	38,209	89,089	2,970	2,062	1,274	884	99	70%
October	38,902	131	19,306	47,327	14,209	119,875	4,060	-	123,935	380	3,997,912	2,776	32,517	91,418	2,949	2,048	1,049	728	91	74%
November	38,891	109	16,476	920	-	56,396	165	-	56,560	174	1,885,348	1,309	17,065	39,495	1,317	914	569	395	4	70%
December	38,733	55	9,753	4,631	-	53,171	-	55	53,116	163	1,713,423	1,190	13,197	39,919	1,288	894	426	296	-	75%
Annual total	405,339	5,223	161,962	319,388	220,601	1,112,514	76,297	2,336	1,186,475	3,641	-	-	332,396	854,079	-	-	-	-	-	72%
Max month	47,060	2,624	20,237	47,327	37,580	141,381	30,912	1,456	161,951	497	5,398,375	3,749	47,141	117,766	3,926	2,726	1,521	1,056	716	
Min month	583	55	-	741	-	36,479	-	-	35,966	110	1,284,506	892	6,917	28,496	1,018	707	223	155	-	
Average Month	33,778	435	13,497	26,616	18,383	92,709	6,358	195	98,873	303	3,238,657	2,249	27,700	71,173	2,332	1,619	907	630	145	
Average daily	1,111	14	444	875	604	3,048	209	6	3,251	10	3,250,616	2,257	911	2,340	-	1,625	-	632	145	
2002																				
January	37,465	286	9,026	8,217	-	54,994	-	286	54,707	168	1,764,755	1,226	13,624	41,083	1,325	920	324	225	-	75%
February	35,511	84	7,942	9,853	-	53,391	543	84	53,850	165	1,923,210	1,336	14,749	39,101	1,396	970	354	246	13	73%
March	39,350	339	17,732	16,817	6	74,245	1	346	73,900	227	2,383,887	1,655	27,595	46,305	1,494	1,037	497	345	0	63%
April	31,833	207	10,845	17,203	24,827	84,914	1,453	-	86,367	265	2,878,913	1,999	32,275	54,092	1,803	1,252	564	392	34	63%
May	37,596	1,683	19,004	26,308	39,388	123,979	1,800	-	125,779	386	4,057,397	2,818	42,021	83,758	2,702	1,876	669	464	40	67%
June	36,224	5,123	17,492	40,227	39,901	138,967	27,351	-	166,318	510	5,543,943	3,850	51,847	114,471	3,816	2,650	812	564	633	69%
6 month total	217,978	7,723	82,042	118,625	104,122	530,489	31,150	716	560,923	1,722	-	-	182,111	378,812	-	-	-	-	-	68%
Max month	39,350	5,123	19,004	40,227	39,901	138,967	27,351	346	166,318	510	5,543,943	3,850	51,847	114,471	3,816	2,650	812	564	633	
Min month	31,833	84	7,942	8,217	-	53,391	-	-	53,850	165	1,764,755	1,226	13,624	39,101	1,325	920	324	225	-	
Average Month	36,330	1,287	13,674	19,771	17,354	88,415	5,192	119	93,487	287	3,092,018	2,147	30,352	63,135	2,089	1,451	537	373	120	
Average daily	1,194	42	450	650	571	2,907	171	4	3,074	9	3,073,549	2,134	998	2,076	-	1,441	-	693	119	

Water use is greatest in the summer and lowest in the winter. AVEK historical water usage is summarized in Table V-2 and Figure V-2. The City has significantly reduced AVEK purchases since 1997.

Table V-2

AVEK Water Usage

Year	Amount (Acre-Feet)	Year	Amount (Acre-Feet)
1980		1991	381
1981	1,887	1992	603
1982	1,645	1993	835
1983	897	1994	980
1984	898	1995	844
1985	259	1996	1,213
1986	52	1997	134
1987	75	1998	342
1088	157	1999	163
1989	190	2000	331
1990	178	2001	317
		Average	**590**

Figure V-2
AVEK Water Use

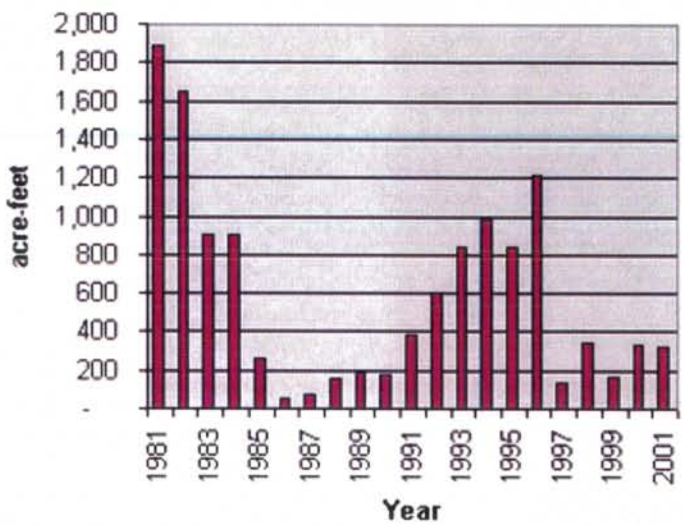


Table V-3 summarizes water use and shows per capita and per household use of water. The average daily demand (ADD) for 2001, the last full year of record, was 3.25 MGD or 353 gallon per capita per day (gpcd). The average per capita use over 2-1/2 years is 339 gpcd. Total annual water production is more than one billion gallons.

Table V-3

Water Use Summary

	2000	2001	2002 (6 mos)	Peaking factor (a)	Average
Annual total	1,178,553,756	1,186,474,765	560,922,782		
Maximum month	164,918,784	161,951,258	166,318,298	1.70	
Minimum month	49,808,336	35,966,168	53,849,868	0.48	
Average Month	98,212,813	98,872,897	93,487,130	1.00	
Average daily demand (ADD)	3,228,914	3,250,616	3,073,549		
Population	8,525	9,215	10,818		
Per Capita Use (gpcd))	379	353	284		339
Occupied housing	3,067	3,066	3,081		
Per house use (gal/house)	1,053	1,060	998		1,037

For Master Plan, use 340 gpcd or 1,050 gallons per house.
(a) Ratio to average day demand (ADD)

The data from Tables V-1 and V-3 were used to develop peaking factors relative to average day demand (ADD). For example, the average day demand during the month of maximum flow (July) was 5.4 MGD, or 1.7 times ADD. Similarly, the average day demand during the minimum month (usually January or February) is 0.48 times ADD.

It was not possible to determine the maximum day demand (MDD) from available records. It is important to know this number, because MDD determines required supply capacity and storage requirement. Palmdale Water District, located at a similar elevation and climate to California City, has data showing that the MDD varies from 1.7 to 2.05 times ADD. Since California City has a known monthly maximum peak of 1.7 times ADD, the 1.7 factor is too low. For the purposes of the Master Plan, the MDD to ADD peaking factor is assumed to be 2.0. Simply stated, the maximum day demand is twice the average day demand. Thus, year 2001 MDD is assumed to be 6.5 MGD.

The peak hour flow and the diurnal variation on demand is also of interest in water system planning. Peak hour flow (PHF) is defined as the single hour of maximum use on the maximum use day of the year. No data is available to precisely determine this peaking factor. Palmdale Water District has measured PHF and determined it to be 1.48 times MDD. For the purposes of the Master Plan, the assumed peaking factors are shown in Table V-4.

Table V-4

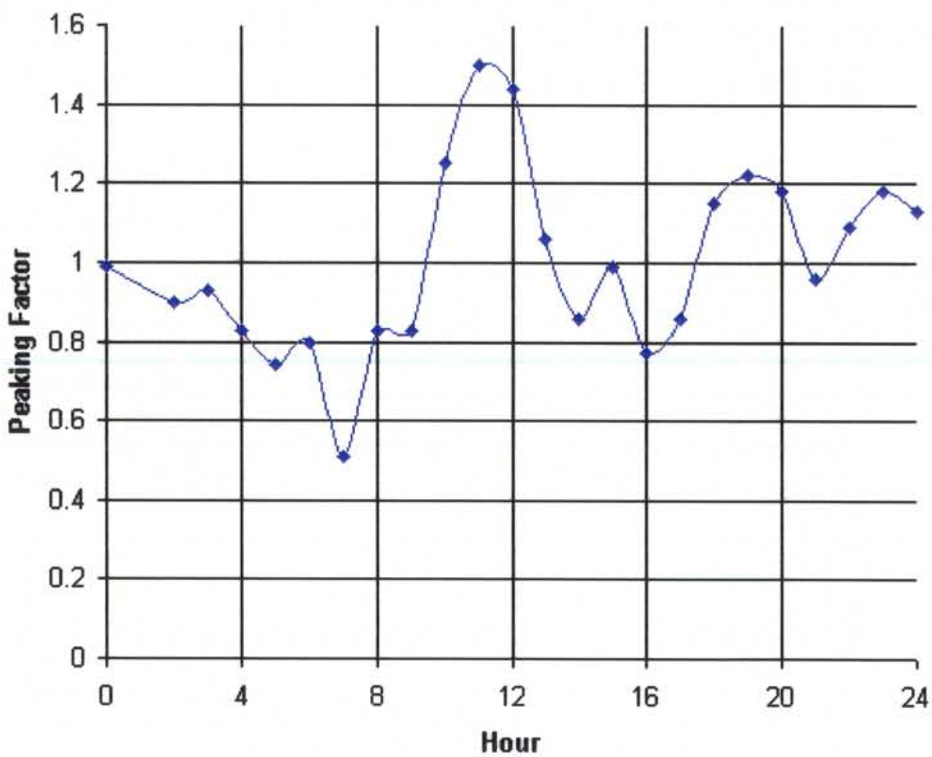
Water Use Peaking Factors

Demand Parameter	Peaking Factor (a)
Average day demand (ADD)	1.0
Minimum month	0.5
Maximum month	1.7
Maximum day demand (MDD)	2.0
Peak hour flow	3.0

(a) ratio to ADD

The diurnal demand curve used in the water system analysis and network model is shown in Figure V-3. The diurnal demand curve was derived from data for Palmdale Water District.

Figure V-3
Water Diurnal Demand



California City per capita water use has been compared to other water purveyors in Table V-5.

Table V-5

Urban Water Use

Water Purveyor or Service Area	Water Production gpcd (a)	Metered	Source
California City	339	yes	(b)
Bakersfield Metro Area	320	mixed	(c)
Vaughn Water (Bakersfield)	388	yes	(c)
Delano	201	mixed	(c)
Tulare	261	no	(d)
Palmdale Water District	235	yes	(e)
Arvin	145	yes	(c)
Wasco	171	no	(c)
San Joaquin portion of Kern Co.	292	mixed	(c)

Sources:
(a) gallons per capita per day
(a) California City water well production records, 2001.
(c) Kern County Water Agency, Water Supply Report 1998
(d) City of Tulare Water System Master Plan, May 1994.
(e) Palmdale Water District Final Water System Master Plan, January 1996

The per capita water use is among the highest of those surveyed. Palmdale Water District, with a similar climate has a per capita use of 245 gpcd. The Bakersfield metro area has a use of 320 gpcd. These comparisons suggest that California City is a high water user and thus could, with conservation, significantly reduce water use. A reduced water use could significantly impact future water system needs as will be shown.

Population Projections

The 2000 census population of California City was 8,525 persons. The California Department of Finance, estimates the January 1, 2002 population to be 10,818 persons. A large part of the two-year growth was the opening of a private prison with a bed capacity of 2,300 persons. Using the 2002 population as a starting point, growth projections based on a low (2 percent annual rate), medium (3.5 percent annual rate) and high growth (5 percent annual rate) scenarios have been prepared in Table V-6 and plotted in Figure V-4.

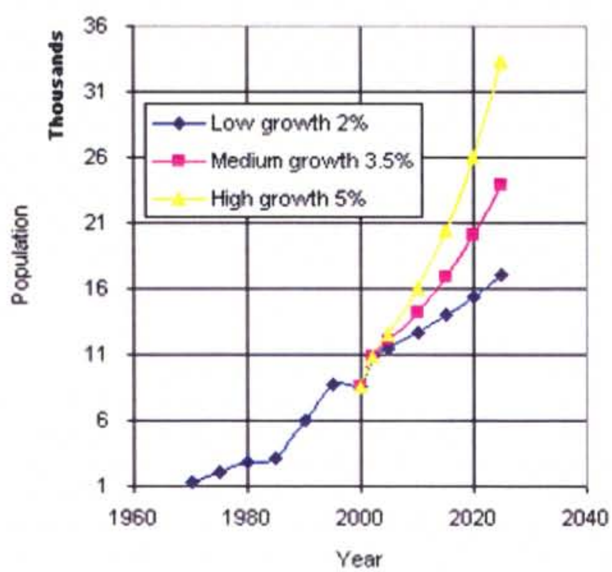
Table V-6

Population Projections

Year	Population	Data Source	Projected Population: Low growth rate 2.0%	Medium growth rate 3.5%	High growth rate 5.0%
1970	1,309	a			
1975	2,091	a			
1980	2,743	a			
1985	3,096	a			
1990	5,955	a			
1995	8,668	a			
2000	8,525	a			
2002	10,818	b	10,818	10,818	10,818
2005			11,480	11,995	12,523
2010	11,846	c	12,676	14,248	15,982
2015			13,996	16,922	20,397
2020	15,016	c	15,453	20,098	26,033
2025			17,062	23,870	33,226

a. US Census 2000
b. California Dept. of Finance Official Estimates.
c. Kern COG from "Interim County Population Estimates"

Figure V-4
Historic and Projected Population



The medium growth rate has been adopted as the base case for evaluating future water demand. It should be noted that Kern County is expected to grow overall at close to a 2 percent rate. The proposed medium growth rate, at 3.5 percent, assumes a significantly higher rate than the surrounding area and significantly higher rate than the official Department of Finance estimate.

Future Water Demand

Future water demand has been estimated by adding growth in water demand to actual water demand for 2001. Future water demand is calculated by the estimated population increase times a per capita average daily demand (ADD) of 340 gpcd. Maximum daily flow (MDD) is determined by using the peaking factors in Table V-4. Alternate scenarios have been developed using a lower per capita demand of 245 gpcd. Table V-7 shows predicted ADD and MDD through year 2025. Also shown are the current available production capacity (largest well out of service) and the current reserve in capacity and the future deficit. The required total storage capacity is also shown.

Table V-7

Future Water Supply Requirements

Year	2002	2005	2010	2015	2020	2025
Population	10,818	11,995	14,248	16,922	20,098	23,870
Supply						
ADD (gal/day)	3,250,616	3,650,796	4,416,816	5,325,976	6,405,816	7,688,296
MDD (gal/day)	6,501,232	7,301,592	8,833,632	10,651,952	12,811,632	15,376,592
MDD (gpm)	4,515	5,071	6,134	7,397	8,897	10,678
Available (gpm)	5,125	5,125	5,125	5,125	5,125	5,125
Reserve/(deficit), (gpm)	610	54	(1,009)	(2,272)	(3,772)	(5,553)
Storage						
25% MDD	1,625,308	1,825,398	2,208,408	2,662,988	3,202,908	3,844,148
Fire Storage	720,000	720,000	720,000	720,000	720,000	720,000
Emergency = MDD	6,501,232	7,301,592	8,833,632	10,651,952	12,811,632	15,376,592
Total	8,846,540	9,846,990	11,762,040	14,034,940	16,734,540	19,940,740

In year 2020, the population is predicted to be 20,098 persons, almost double the current population. Water demand is also expected to almost double to approximately 6.4 MGD, ADD and 12.8 MGD, MDD. Total storage required is 16.7 MG, less that currently available.

Alternate future water supply scenarios are shown in Table V-8 for the three population growth scenarios and two per capita water use assumptions.

Table V-8

Future Water Supply Scenarios
Year 2020

Population Growth Scenario	Per capita water use 340 gpcd	245 gpcd
	MDD (MGD)	
High growth (5%)	16.85	13.96
Medium growth (3.5%)	12.81	11.05
Low growth (2%)	9.65	8.77
	Storage Required (MG)	
High growth (5%)	21.8	18.2
Medium growth (3.5%)	16.7	14.5
Low growth (2%)	12.8	11.7
	No. of 1000 gpm wells	
High growth (5%)	10	7
Medium growth (3.5%)	6	4
Low growth (2%)	3	2

The difference between the best case (low growth, low per capita use) and the worst case (high growth, high per capita use) is a future MDD of 8.77 MGD versus 16.85 MGD. Another way to view this is that the City would need to complete construction of two new 1000 gpm wells in the best case and 10 new wells in the worst case. This information is provided to show the sensitivity of this analysis to assumptions made for the Master Plan.

VI Water System Evaluation

This section presents an evaluation of the existing water system with the objective of identifying deficiencies in the system and planning for growth to the year 2020. The evaluation addresses each of the major components of the water system: transmission and distribution, supply, treatment and storage.

Transmission and Distribution System

A computer model of the water system network and simulation of system operations was the primary tool in the evaluation of the transmission and distribution system. The system was also evaluated based on modern engineering standards used for water system design and construction. The computer network model utilized Haestad Methods WaterCAD® v4.5 to model and simulate the water system. WaterCAD® v4.5 has the capability to model up to 2,000 pipes and 2,000 junctions. In California City, this allowed the modeling of nearly all pipes in the First Community. Generally, a water system is skeletonized, with small diameter and dead end pipes eliminated to facilitate model development. In California City, only dead end pipes and some small diameter pipes were eliminated to keep the system within the limits of the model. No significant loss of accuracy occurs with selective skeletonizing.

The model is capable of both steady state and extended period simulation. A steady state simulation represents a single point in time and is used to evaluate system operation under static conditions. Extended period simulations are used to evaluate the water system over time such as a 24-hour period. Pumps and reservoirs are modeled to simulate, as closely as possible, the real world operation. This is especially useful in determining how the system responds to variations in demand over time.

Summary data for the model is presented in Appendix E. The model was developed by using the California City water base maps and importing them directly into WaterCAD®. This allowed all the pipes to be automatically incorporated into the model with the correct size and length. The ground elevation for each junction was added based on USGS topographic maps. Pumps and reservoirs were modeled based on data provided by the Water Department staff. Whenever possible, actual pump curves and actual reservoir operating parameters were utilized to make the model as realistic as possible. Water demand was based on average daily demand (ADD) for the year 2001. Demand was distributed to the junctions based on a count of existing homes and businesses within sub-areas in the First Community. Water demand for the Second Community was set at the average flow rate used in 2001. These parameters establish the "Base" model. All other scenarios build from the base. Applying a multiplication factor to the base case demands allows the model to simulate MDD, PHF and other scenarios. The model has the ability to test each junction automatically for fire flow. The diurnal demand curve shown in Figure V-3 was used for extended period simulations.

Table VI-1
Pressure at Key Junctions

	Junction No	Ground Elevation	Location	Static Pressure
			First Community Pressure Zone B1	
1	J-972	2,492.40	CA City Blvd. @ Baron Blvd.	44.0
2	J-5675	2,466.60	CA City Blvd. @ Mitchell	55.2
3	**J-5276**	**2,443.70**	**CA City Blvd. @ Yerba (Well 2)**	**65.1**
4	J-6534	2,418.72	CA City Blvd. @ Isabella Blvd..	75.9
5	**J-6850**	**2,400.85**	**CA City Blvd. @ Neuralia (Well 3)**	**83.6**
6	J-969	2,380.00	CA City Blvd. @ N/S Loop Rd.	92.6
7	J-5472	2,360.58	CA City Blvd. @ Hacienda Blvd..	101.0
8	J-5669	2,350.99	CA City Blvd. @ Conklin Blvd..	105.2
9	**J-2473**	**2,350.00**	**CA City Blvd. @ Mojave/Randsburg (AVEK)**	**105.6**
10	**J-6846**	**2,408.38**	**Neuralia @ Well 15A**	**80.4**
11	**J-5755**	**2,389.91**	**Great Circle Dr. @ Well 10**	**88.4**
12	**J-887**	**2,423.25**	**Yerba Blvd. @ Mendiburu Rd. (Well 14)**	**73.9**
13	J-4401	2,354.44	Lindbergh Blvd. @ Rusche Blvd..	103.7
14	J-2584	2,355.12	Mendiburu @ Hacienda	103.4
15	J-846	2,316.13	Nelson Dr. @ WWTP	120.3
16	J-5859	2,343.53	Randsburg/Mojave Rd - 20"	108.4
17	J-5643	2,344.89	Mendiburu @ Randsburg/Mojave	107.8
18	J-5692	2,359.22	Hacienda @ N. Loop	101.6
19	J-6889	2,369.88	Hacienda @ S. Loop	97.0
20	J-5242	2,383.76	Mendiburu @Neuralia	91.0
21	J-5451	2,448.70	Lindbergh Blvd. @ end	62.9
22	J-6521	2,447.20	Great Circle @Yerba	63.5
23	J-1869	2,439.86	Isabella @ Moss Avenue	66.7
24	J-5539	2,422.05	Sequoia @ Neuralia	74.4
25	J-4370	2,415.62	Redwood @ Neuralia	77.2
26	J-5636	2,399.47	Sequoia @ Airway	84.2
27	J-5537	2,382.30	Sequoia @ Hacienda	91.6
28	J-5386	2,377.22	Sequoia @ Desert Butte	93.8
29	J-4384	2,369.88	Sequoia @ Carson Dr.	97.0
30	J-5651	2,350.12	CA City Blvd. @ Redwood	105.6
31	J-5377	2,392.88	Rosewood @ Hacienda (before pump)	87.1
			Rancho System Pressure Zone C-2	
32	J-5370	2,393.21	Rosewood @ Hacienda (after pump)	137.1
33	J-5621	2,400.00	Rosewood @ Hidalgo	134.2
34	J-820	2,416.84		126.9
35	J-5511	2,462.14	Hacienda Blvd. @ Joshua	107.3
36	T-Rancho	2,689.80	Hacienda Blvd. @ Rancho Tank	8.7
37	J-879	2,460.03	El Camino @ Ridge Blvd..	108.2
38	J-1145	2,557.80	Twin Buttes @ El Camino	65.9
39	J-5267	2,442.69	Joshua Blvd. @ Hidalgo	115.7
40	J-1135	2,445.28	Foothill @ Knoll	114.6
41	J-5235	2,543.26	Hacienda @ Ridge	72.2
42	J-5658	2,400.49	Hacienda @ Beachwood	134.0

Maximum elevation 2.5 MG tank = 2,594.00
Maximum elevation Rancho Tank = 2,710.00

The model is capable of providing results for each pipe, junction, pump, reservoir etc. for each point in time evaluated. The model can also provide time graphs, pressure contour maps and summary tables. To simplify the evaluation, key junctions were selected for evaluation. These junctions, shown in Figure VI-1 and listed in Table VI-1, are representative of key areas within the First Community and Rancho Tract. The key parameters reviewed in the system model are junction pressure, pipe velocity, pipe friction headloss and fire flow capability. Pressure and velocity are evaluated against criteria shown in Table IV-1. Fire flow is evaluated in terms of meeting minimum fire flow and residual pressure as shown in Table IV-1.

The model results for the existing system; base case (ADD) and MDD showed that the current transmission and distribution system is generally adequate with some exceptions on fire flow. Some observations from model results are:

- Pressure is highest on the east and northeast end of the First Community, closest to Cache Creek. This is due to low elevation and thus high static pressure. Pressure exceeds 80 psi in most of the east half of the First Community, and thus pressure regulators are required.
- Pressure is lowest at the west end of town and near the airport, due to elevation and low static pressure. Distance from the 2.5 MG reservoir also contributes to the low pressure. Airport area pressure and fire flow could be improved by adding some missing link pipelines. The lowest static pressure, approximately 44 psi, is near Baron Blvd. at California City Blvd..
- Higher pressure occurs near the water wells when they are operating. Pressure at the west end of the First Community improves when the well pumps are operating.
- Very high pressures exist in the Rancho Tract, Section 5, south of Beachwood Avenue. Pressures exceeding 120 psi occur in this area due to low elevation and high static pressure. This area is fed by the Rancho Reservoir, but could be in pressure zone B-1, with the rest of the First Community.
- Fire flow is generally adequate, but is often restricted in areas with significant length of 4-inch diameter pipes. Fire flow in the airport area is limited.
- Fire flow in the upper Rancho hydropneumatic zone is limited to approximately 550 gpm, due to the small size of the existing pumps. This pressure zone does not meet the current UFC requirement of 1,000 gpm for residential areas.

As previously discussed, the major deficiency in the distribution system is the integrity of the existing steel water pipes. These pipes have exceeded their expected life and are currently a liability to the City. Many steel pipes are seriously corroded and in need of immediate repair. It is recommended that a program be established to replace all steel water pipe within the First Community. In conjunction with the replacement program, water mains should be sized in accordance with the recommendation of Table IV-1. All distribution system pipes should be 6-inch, 8-inch or 12-inch. The increased pipe sizes will improve pressure and fire flow capabilities.

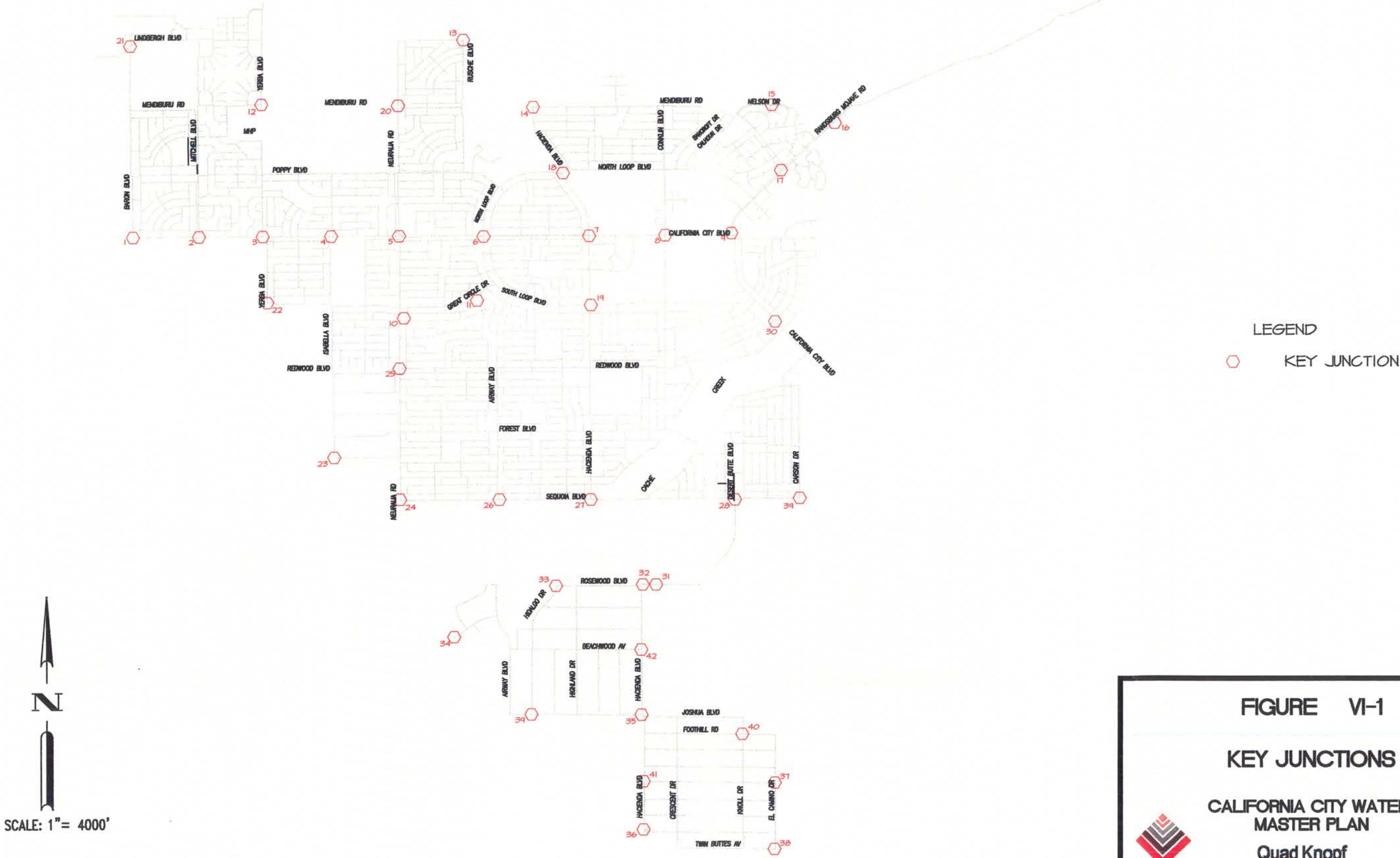


FIGURE VI-1

KEY JUNCTIONS

CALIFORNIA CITY WATER MASTER PLAN

Quad Knopf

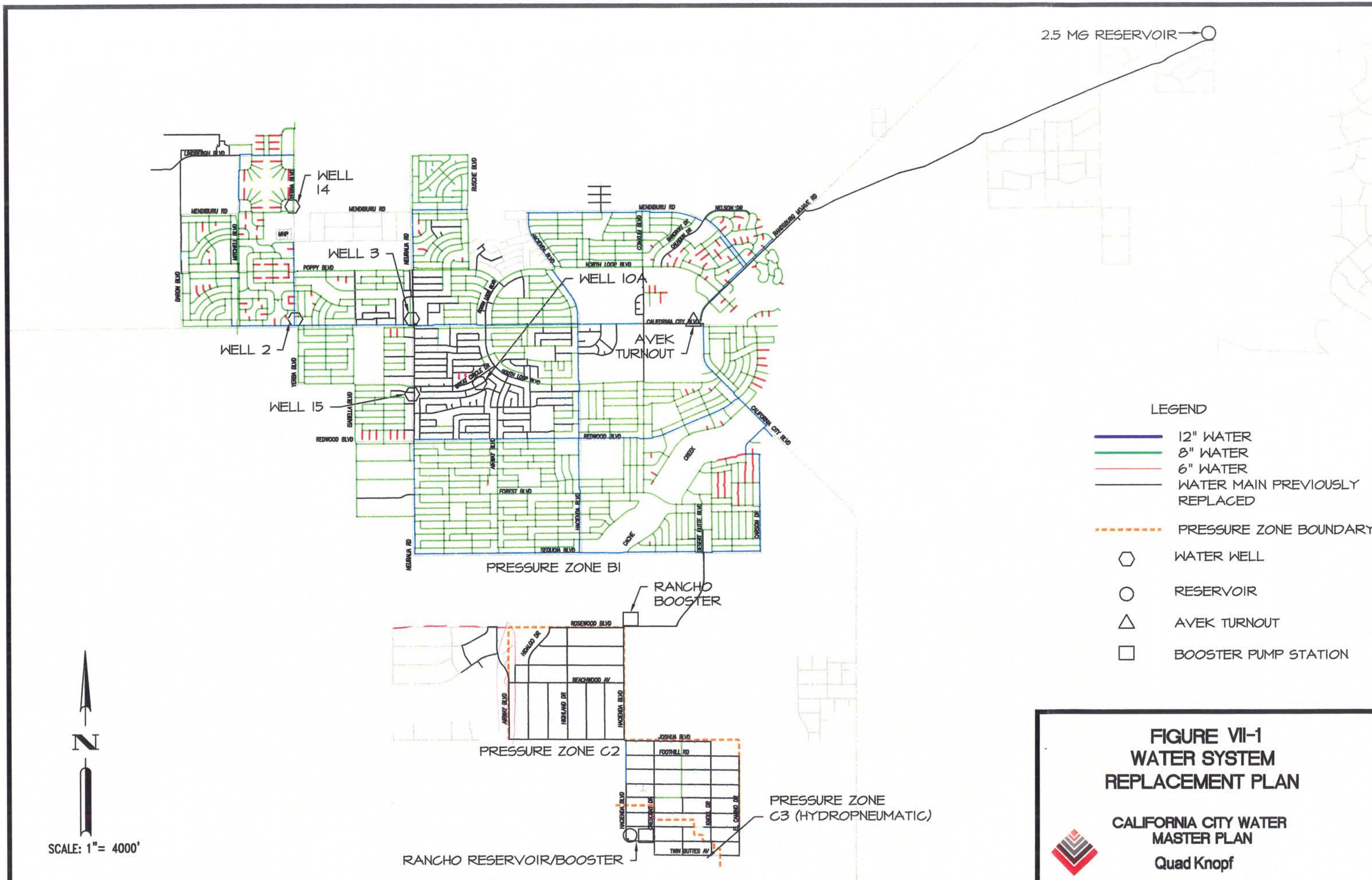


FIGURE VII-1
WATER SYSTEM REPLACEMENT PLAN

CALIFORNIA CITY WATER MASTER PLAN

Quad Knopf

Supply

The current water production capacity is summarized in Table VI-2. The five water wells currently produce 4,425 gpm. The AVEK turnout provides 1,700 gpm. As discussed in Section IV, the water supply should be rated with the largest well out of service. The largest well, Well 15a, produces 1,000 gpm. If it is out of service, the well capacity is 3,425 gpm with a MDD of 4,515 gpm. Thus, without use of AVEK, the current water supply is deficient for MDD by 1,090 gpm. With AVEK, there is a reserve of 610 gpm.

Table VI-2

Water Production Capacity Summary

Well Number	Current production 08/30/2002 (gpm)
Well 2a	900
Well 3	800
Well 10	875
Well 14	850
Well 15a	1,000
Total	4,425
Largest well (15a)	1,000
Total capacity with largest well out of service	3,425
AVEK connection	1,700
Total capacity with AVEK and largest well out of service	**5,125**
Current max day demand (MDD)	4,515
Reserve	610

Water supply is recommended to be available from 3 to 5 years ahead of demand. There is an immediate need for one to two new water wells to meet current demand with the recommended reserve.

Treatment

California City well water currently meets all state and federal drinking water standards without treatment. AVEK water is treated prior to delivery to California City. It also meets all drinking water standards. Sodium hypochlorite (liquid chlorine) is injected into the water wells for disinfection purposes. Operating staff has noted that the AVEK water is often low in chlorine residual. Since there is no means of adding chlorine, staff is reluctant to use AVEK water. The lack of chlorine residual could cause a bad coliform bacteria test in the distribution system. The

VII Future Water System

The future water system recommended for California City is based on the medium growth, current water use scenario as discussed in Section V. The year 2020 population is projected to be approximately 20,100 persons. Water use will remain at 340 gpcd. The MDD will be 12.8 MGD and total storage volume required will be 16.7 MG. Section V, Table V-8, presented alternate scenarios where both growth and per capita water consumption varies. If the assumptions regarding growth and or water usage prove to be incorrect, the City can either accelerate the Master Plan improvements or stretch them out over a longer period of time. Water well and storage reservoir construction can easily be timed to meet actual growth needs.

Transmission and Distribution System

The future water system assumes that a replacement program is implemented to replace all existing steel water mains. The steel pipe mains will be replaced with 6-inch, 8-inch and 12-inch water mains constructed of PVC or other corrosion resistant materials. It is assumed that the replacement program will be carried out over a period of 10 or more years and that it will be complete before 2020. Twelve-inch water mains are recommended to be placed at approximately one-mile intervals. Each square mile would have a 12-inch or larger main loop around it. A 12-inch water main is the recommended minimum size for connection to the water well. The water main replacement program is shown in Figure VII-1.

In addition to the water main replacement program, it is recommended that a 16-inch water main loop be constructed, connecting the east and west sides of the First Community. The loop will facilitate movement of water from the water wells, which are generally located in the west, the AVEK connection, located in the east and the existing 2.5 MG reservoir located in the northeast. It would also facilitate the movement of water to a proposed new west reservoir. A large diameter main will minimize friction head losses, maximize fire flows and will minimize pressure variations with well on/off operation. The proposed transmission and distribution improvements are shown on Figure VII-2.

A high-pressure zone exists in the Rancho Tract, generally north of Beachwood Avenue. This area is currently in Pressure Zone C-2 and is fed by gravity from the Rancho Reservoir. It is recommended that this area be included in Pressure Zone B-1, which serves the First Community. It is recommended that a new 10-inch water main be constructed from the lower Rancho Booster pump station to Hacienda Blvd. at Joshua Blvd. This line would parallel the existing line but would carry the discharge from the booster station. Valves and and piping would be modified to separate the pressure zones at Joshua Blvd. A new 8-inch water main would also be constructed from Sequoia Blvd. at Airway Blvd. to Rosewood Blvd., effectively looping Pressure Zone B-1 to the lower Rancho Tract. Pressures would be reduced in the lower Rancho Tract by about 50 psi. The revised pressure zone boundary is shown in Figure VII-2.

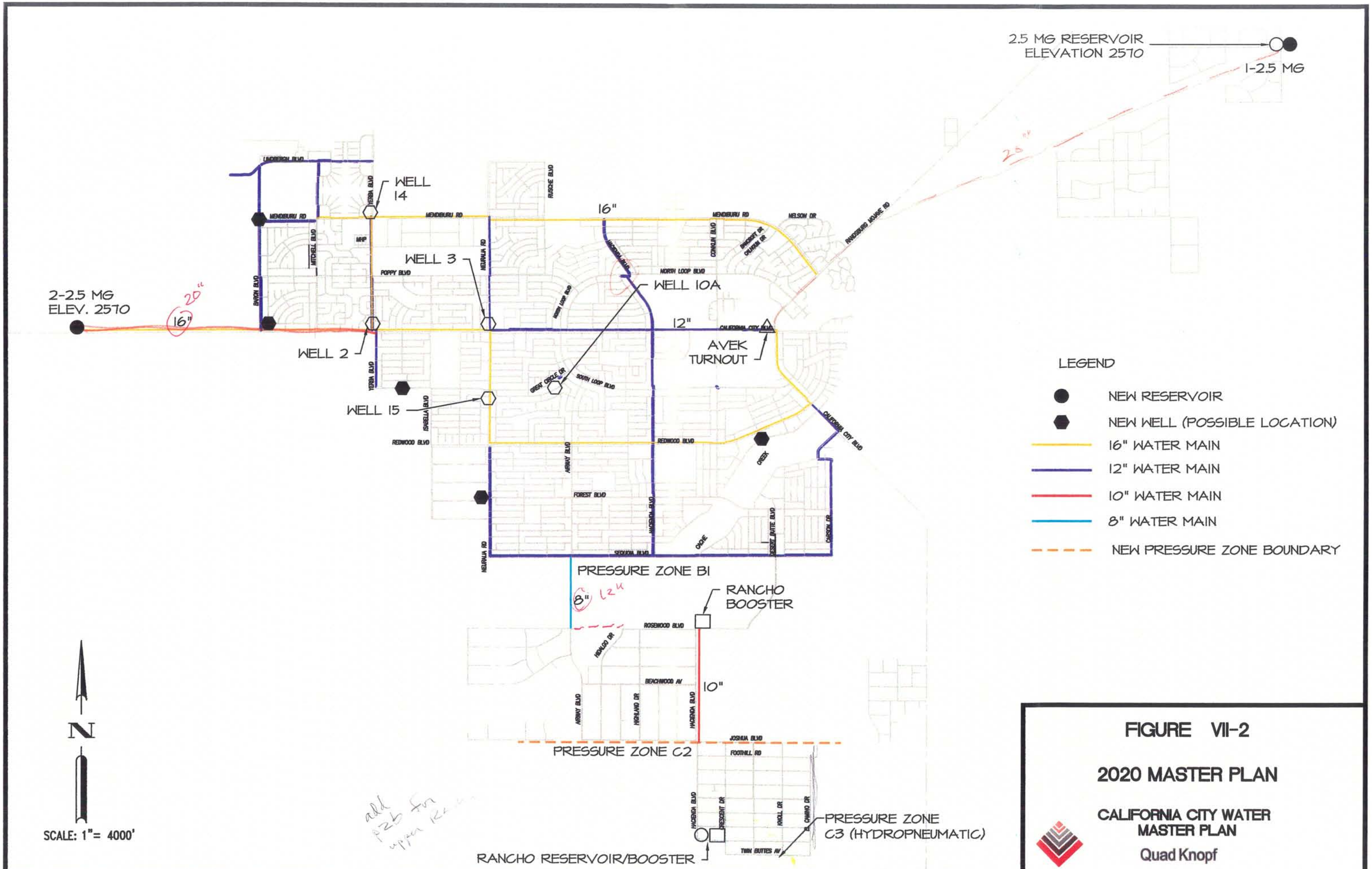


FIGURE VII-2

2020 MASTER PLAN

CALIFORNIA CITY WATER MASTER PLAN

Quad Knopf

Fire flow to the upper Rancho hydropneumatic zone is limited to the capacity of the existing pumps, or approximately 550 gpm. The current minimum residential fire flow requirement is 1,000 gpm. It is therefore recommended that a 1000 gpm fire pump be added to the upper Rancho booster system.

Supply

The future water supply scenario assumes the continued operation of the existing five well pumps and full utilization of AVEK at its current capacity of 1,700 gpm. Approximately 3,800 gpm of new water supply will need to be developed by 2020 (Table V-7). The average well in California City currently produces between 800 to 1,000 gpm, thus, approximately four to five new wells must be constructed. Alternatively, additional supply could be obtained from the AVEK turnout if a booster pump system is constructed. The 18-inch AVEK California City feeder could produce up to 4,000 gpm, if a booster pump station was added to boost pressure.

The future water supply assumes that five new water wells, each producing 1,000 gpm, are constructed. The location of the new wells has not been determined at this time. It is assumed that the target locations would be adjacent to either a 16-inch or 12-inch water main. For the purpose of developing the future hydraulic network model, five locations were selected which are spaced about one mile apart from the existing wells (Figure VII-2). The actual location for future water wells should be based on a study of groundwater hydrology in the area. Several past attempts to drill new water wells have resulted in dry holes. It is apparent that finding a groundwater supply, with a sustainable yield, may be fraught with risk. It is therefore recommended that any groundwater hydrology study be supplemented with the drilling of test wells prior to drilling a production well. Test well drilling is the only way to verify recommendations made in a groundwater hydrology study.

The City should consider utilizing more AVEK water, even if it costs more than City well water. The City is recommended to establish a pattern of use, which would give it priority to more AVEK water, should it be cut back in the future. AVEK water supply is very much under utilized currently. Assuming that groundwater is ultimately limited in yield, the use of imported surface water will preserve the groundwater supply. The City may need to construct a chlorine feed station at the AVEK turnout to facilitate the use of the water. A booster pump station could yield an additional 2,300 gpm of AVEK water, thus eliminating the need to construct two to three new wells. A booster pump station and chlorine feed facilities could be constructed at a much lower cost than a new well. The City should begin negotiations with AVEK to secure the additional supply for the future.

Future water supply demand could be further reduced by wastewater reclamation. At a population of 20,100 persons, approximately 1.6 MGD of wastewater is produced. If the wastewater is fully reclaimed, so that it can replace potable water use, it could replace one new water well and eliminate the need for about 2 MG of storage.

Similarly, if per capita water use is reduced to 245 gpcd, the City will eliminate the need for two new water wells and 2.2 MG storage.

Treatment

No treatment facilities are anticipated to be required during the Master Plan period. However, the quality of groundwater could change over time or new wells may yield poorer quality groundwater that may require treatment. Drinking water standards may also change in the future. The City should continue to monitor drinking water regulations to determine the effect on its system.

Storage

Year 2020 total storage volume required is 16.7 MG. Storage volume currently available, including equivalent storage from upper phase reservoirs, AVEK supply and supply from the engine driven Well 3 is 9.3 MG (Section VI). Thus, new storage volume equal to 7.4 MG is required to be constructed by 2020. The storage volume can be achieved by a combination of new reservoir construction or by providing new water wells with engine drives or emergency generators. For example, a new 1,000 gpm well, with an emergency generator could provide the equivalent storage of 1.4 MG (1,000 gpm x 1440 min/day). It should be noted that storage requiring a pump is less reliable than a gravity storage reservoir and thus gravity storage is recommended.

The Master Plan recommendation is to provide three new 2.5 MG reservoirs, to be constructed in phases by year 2020. Two new 2.5 MG reservoirs are proposed to be constructed on the west end of town at the same top and bottom elevation as the existing 2.5 MG reservoir on Twenty Mule Team Parkway. A 2-mile long 16-inch water transmission main will connect the west reservoirs to the First Community water system at Baron Blvd. (Figure VII-2) A second 2.5 MG reservoir will be constructed adjacent to the existing east 2.5 MG reservoir.

The west reservoir is recommended to improve pressure on the west side of town and in the airport industrial area. The proposed west reservoirs will be closer to the water wells and will help balance water pressure throughout the First Community. It will also improve overall system reliability. California City is fortunate to be surrounded on three sides by high ground that allows the use of a ground level reservoir at an elevation that meets the hydraulic grade line requirements of the water system. The west reservoirs will also facilitate future transport of water to Wonder Acres. If well fields were located west of the First Community, it would also facilitate their use.

Storage can be utilized for time of use (TOU) pricing of electric energy. TOU pricing allows the City to pay less for electric energy during non-peak hours and much higher prices during peak hours, generally from noon to 6 p.m., Monday through Friday. To take advantage of TOU pricing, the City would shut off all electric operated well pumps from noon to 6 p.m. Water would be delivered during peak hours from storage, from the AVEK connection or from engine operated wells. Full TOU operation requires that the full-day demand be met from water wells operating 18 hours per day. Thus, the number of wells required would increase by one-third. Approximately 3.2 MG of storage would need to be allocated for TOU operation in year 2020 MDD. Storage could be allocated from storage set aside for future growth. In some cases, energy savings can be used to finance needed improvements. Additional study is recommended to determine if this would be advantageous for the City.

Future Water System Model

The future water system was modeled using Haestad Methods WaterCAD® v4.5. The model incorporates all of the improvements shown in Figure VII-1 and VII-2, including the complete water system replacement. The model is based on a year 2020 MDD of 12.8 MGD. The model assumed that most growth would occur in the First Community. The growth in demand for the Second Community was assumed to be half that of the First Community. Water demand was distributed to junctions in accordance with expected growth patterns.

The water system was modeled for the following scenarios in year 2020:

- Average daily demand (ADD)
- Maximum daily demand (MDD)
- Fire flow
- Emergency, pumps off.

Summary data for the model simulations is presented in Appendix E. Some observations of the model simulations are:

- The future model shows the water system performing well with higher fire flow and improved pressure on the west side.
- The proposed west reservoirs fill before the existing east reservoir, suggesting that system controls may need to be modified when the tank is constructed.
- Fire flow was tested throughout the City with available fire flow generally greater than 4,000 gpm at or near the 12-inch and larger mains. Residential areas, with 8-inch mains generally provided more than 1,500 gpm fire flow. Fire flow availability was lower in the west, upper elevation areas.

VIII Master Plan Recommendations

This section presents the recommendations of the Master Plan, estimated costs and implementation schedule.

Master Plan Recommendations

It is recommended that the City implement the following Master Plan:

1. Adopt the water system planning criteria and fire flow requirements as presented in Section III. The criterion should be used to guide the development of improvements to the water system.
2. Continuously monitor water demand, well production, per capita water use and other water system operating parameters to determine if adjustments are needed in assumptions made for the Master Plan. The Master Plan should be a dynamic document.
3. Implement a steel water pipe replacement program such that all steel water mains are 100 percent replaced by 2020. Existing pipes should be replaced with 6-inch, 8-inch and 12-inch water mains as shown in Figure VII-1. Fire hydrants and services are recommended to be replaced at the same time. This program is urgently needed to maintain the integrity and reliability of the existing system.
4. Construct the master planned water distribution improvements, including 12-inch and 16-inch water mains as shown in Figure VII-2.
5. Construct chlorination facilities on the AVEK turnout.
6. Utilize AVEK water to its maximum potential to establish a priority of use. AVEK water will preserve groundwater. The future water supply scenarios presented in the Master Plan assume full utilization of AVEK water. The city should also consider installing a booster pump system on the AVEK turnout to boost its supply capability to 4,000 gpm. If additional AVEK water can be obtained, the City could delay construction of one to two new wells.
7. Construct approximately five new water wells by year 2020. The new wells should collectively produce a minimum of 4,000 gpm. Water well construction should be preceded by a groundwater hydrogeology study to determine the best locations for well drilling. Test wells should be drilled prior to production well drilling. If possible, water wells should be located adjacent to 12-inch or larger mains. Three wells should be provided with emergency power.
8. Construct 7.5 MG of new storage by 2020. A new reservoir site, about 2 miles west of Baron Blvd. on California City Blvd. should be acquired for the construction of two 2.5 MG reservoirs. The site should be selected so that the new reservoirs can be constructed at the same bottom and top elevations as the existing reservoir. A second 2.5 MG reservoir is recommended to be constructed adjacent to the existing reservoir.
9. Add a 1,000-gpm fire pump to the upper Rancho hydropneumatic system.
10. Separate the Rancho Tract into two pressure zones by constructing a parallel 10-inch pipeline from the lower Rancho Tract boosters to Joshua Blvd. Add an 8-inch water main from Airway Blvd. at Sequoia Blvd. to Rosewood Blvd. so that the Rancho Tract has looped water feed.

11. Study the benefits of going to "time of use" (TOU) pricing for water well pumping electric energy. With additional storage and well pump capacity available, TOU pricing could subsidize part of the cost of new facilities.

Costs

Planning level, concept cost estimates have been prepared for the Master Plan improvements. The estimates are to be considered "order of magnitude." These estimates are based on current dollars (September 2002).

Costs for the water main replacement program are presented in Table VIII-1. These costs have been separated from the "Master Plan" costs because this program is required regardless of growth in California City. Replacement costs should be borne by all owners of parcels having water availability. In contrast, the Master Plan improvements are required to accommodate growth and thus its costs should be primarily borne by new growth.

Table XIII-1

Water Main Replacement Program
Concept Level Planning Estimate

Item	Quantity	Units	Unit cost		Item cost
12-inch water main	86,850	lf	40	$	3,474,000
8-inch water main	834,634	lf	30		25,039,020
6-inch water main	43,114	lf	25		1,077,850
12-inch water valves	60	ea	1,250		75,000
8-inch water valves	2,055	ea	800		1,644,000
6-inch water valves	100	ea	600		60,000
Fire Hydrant Assembly	1,930	ea	2,200		4,246,000
Water service replacement	2,500	ea	250		625,000
Subtotal					36,240,870
Contingency (15%)					5,436,131
Total				**$**	**41,677,001**

The order of magnitude cost for the water main replacement program is nearly $42 million. This is a staggering sum for a City with only approximately 3,200 water connections. However, when spread our over approximately 30,000 parcels which currently have a water main fronting their property or serving their property, the unit cost becomes a more reasonable $1,400 per parcel.

Cost for the Master Plan improvements are shown in Table VIII-2. The total cost is approximately $14 million. The City is expected to grow by 9,280 persons by 2020. Assuming an average household size of 2.7 persons, which was typical of owner occupied housing in the

2000 census, an additional 3,440 homes will have been built. If the Master Plan cost is spread out over just these homes, the cost is approximately $4,070 per equivalent dwelling unit.

The City needs to consider how to fund the improvements. Obviously, with such high cost, the City will have to avail itself of every possible funding source and mechanism. It is recommended that the City consider the use of an assessment district to fund the water main replacement program. The funding mechanism should spread costs over all parcels with water availability. In contrast, the Master Plan improvements primarily benefit new development and thus funding should reflect that. The City should also pursue grants and loans to fund improvements.

Table VIII-2

Water Master Plan Summary Costs
Concept Level Planning Estimate

Item No.	Item Description	Quantity	Unit	Unit Cost		Item Cost
1	16-inch water main	75,980	lf	60	$	4,558,800
2	16-inch BFV	25	ea.	2,400		60,000
3	10-inch water main	5,300	lf	30		159,000
4	8-inch water main	3,500	lf	25		87,500
5	Rancho fire pump	1	ea.	10,000		10,000
6	Water Well	5	ea.	1,125,000		5,625,000
7	2.5 MG Reservoir	3	ea.	1,055,000		3,165,000
8	AVEK chlorination system	1	LS	60,000		60,000
	Total				$	13,725,300

Notes:
1. 12-inch mains and valves included in replacement program.
2. Costs are based on September 2002

Implementation Schedule

The recommended schedule for implementation is:

1. Water Main Replacement Program. This should begin immediately and should proceed as rapidly as funds are available. The priority for construction should be those areas with the worst incidence of leakage combined with greatest population. The project work should be phased over approximately the next 10 to 15 years.
2. Water Wells. Two new water wells should be planned immediately and constructed within the next two to three years. Additional wells should be constructed approximately five years thereafter. Water wells would, therefore, be constructed in approximately 2003, 2005, 2010, 2014 and 2018.
3. Water Storage Reservoirs. Planning should begin immediately for one 2.5 MG reservoir and construction should be complete by 2005. Additional 2.5 MG reservoirs should be constructed and operational by 2010 and 2015. The 16-inch water transmission line to the west reservoir must be constructed with the first west reservoir.

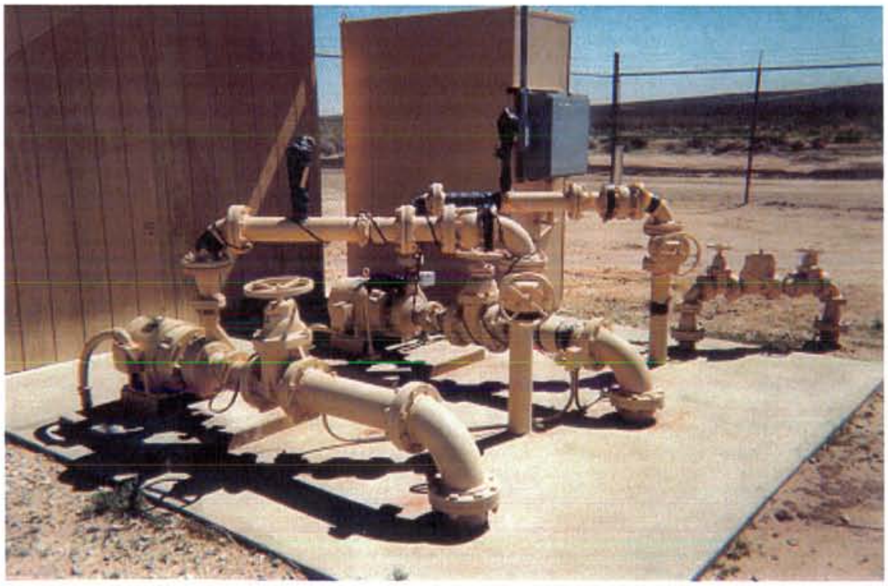
4. Water distribution system improvements, including the 16-inch loop should be phased in starting in 2005 with completion by 2015.
5. Water chlorination facilities for the AVEK turnout should be constructed immediately so that the full supply of AVEK water can be utilized.

APPENDIX A

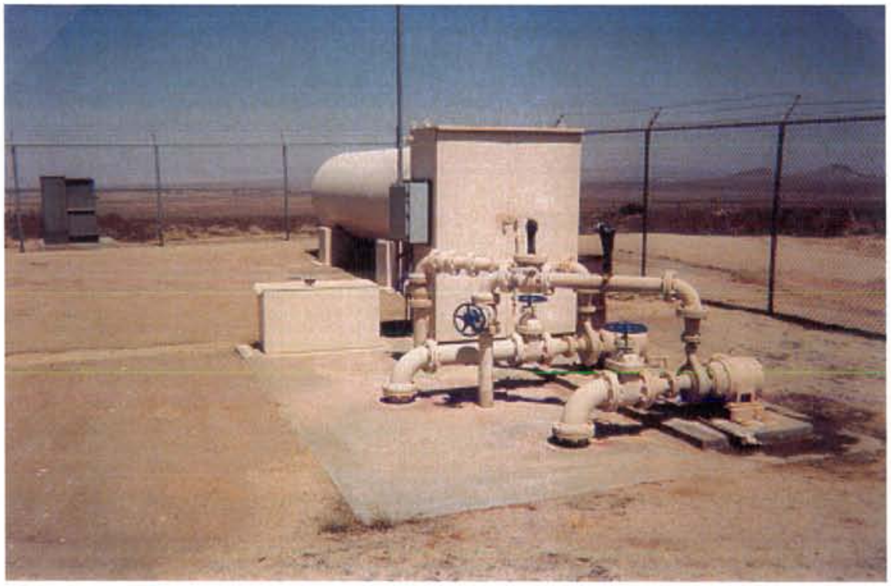
Photo Plates

2.5 MG Water Reservoir
Photo Plate 1

Rancho Tract Reservoir
Photo Plate 2



Lower Rancho Tract Booster Pump
Photo Plate 3

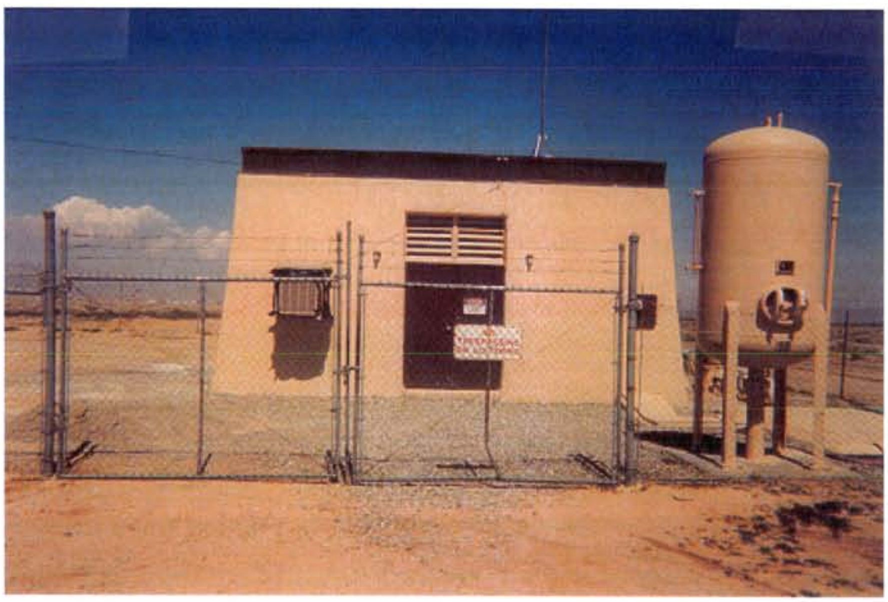


Rancho Tract-Upper Hydropreumatic System
Photo Plate 4

Well 2A
Photo Plate 5

Well 3
Photo Plate 6

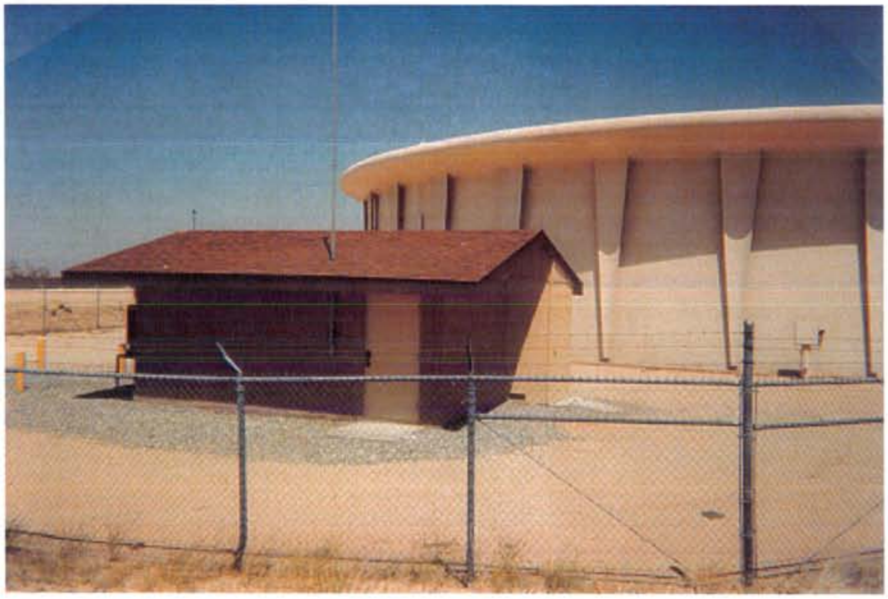
Well 10
Photo Plate 7



Well 14
Photo Plate 8

Well 15A
Photo Plate 9

AVEK Turnout
Photo Plate 10



Booster Pump
Photo Plate 11